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STAINLESS STEEL MATERIAL HAVING EXCELLENT RUST RESISTANCE AND PRODUCTION METHOD THEREOF

[TAISEISEI NI SUGURETA SUTENRESU KOZAI OYOBI SONO SEIHO]

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Specification

1. Title of the Invention

Stainless steel material having excellent rust resistance and the production thereof

2. Scope of Patent Claims

(1) A ferritic stainless steel material having excellent rust resistance, characterized in that a ferritic stainless steel base material which contains, on a weight basis,

Al: 0.003 % or less; Si: 0.3 to 5 %;

Mn: 0.2 to 1 %; and Cr: 8 to 25 % or less;

with the balance substantially being Fe, is provided, on the surface thereof, with a single-layered or multi-layered vapor-phase plated layer which is constituted of at least one component selected from the group consisting of Al, Ti, Si, Nb, Cr, Mo, Cu, Ni, nitrides thereof and oxides thereof, and has a thickness of 200 to 30,000 Å.

(2) A ferritic stainless steel material having excellent rust resistance, characterized in that a ferritic stainless steel base material which contains, on a weight basis,

Al: 0.003 % or less; Si: 0.3 to 5 %;

Mn: 0.2 to 1 %; Cr: 8 to 25 % or less;

and at least one component selected from the following group:

Cu: 0.05 to 0.8 %; Ni: 0.05 to 0.8 %;

Nb: 0.05 to 2.0 %; and Mo: 0.05 to 3.0 %;

with the balance substantially being Fe, is provided, on the surface thereof, with a single-layered or multi-layered vapor-phase plated layer which is constituted of at least one component selected from the group consisting of Al, Ti, Si, Nb, Cr, Mo, Cu, Ni, nitrides thereof and oxides thereof, and has a thickness of 200 to 30,000 Å.

(3) A ferritic stainless steel material having excellent rust resistance, characterized in that a ferritic stainless steel base material which contains, on a weight basis,

Al: 0.1 to 4 % or less; Si: 0.3 to 5 %;

Mn: 0.2 to 1 %; and Cr: 8 to 25 % or less;

with the balance substantially being Fe, is provided, on the surface thereof, with a single-layered or multi-layered vapor-phase plated layer which is constituted of at least one component selected from the group consisting of Al, Ti, Si, Nb, Cr, Mo, Cu, Ni, nitrides thereof and oxides thereof, and has a thickness of 200 to 30,000 Å.

(4) A ferritic stainless steel material having excellent rust

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resistance, characterized in that a ferritic stainless steel base material which contains, on a weight basis,

Al: 0.1 to 4 %; Si: 0.3 to 5 %;

Mn: 0.2 to 1 %; Cr: 8 to 25 % or less;

and at least one component selected from the following group:

Cu: 0.05 to 0.8 %; Ni: 0.05 to 0.8 %;

Nb: 0.05 to 2.0 %; and Mo: 0.05 to 3.0 %;

with the balance substantially being Fe, is provided, on the surface thereof, with a single-layered or multi-layered vapor-phase plated layer which is constituted of at least one component selected from the group consisting of Al, Ti, Si, Nb, Cr, Mo, Cu, Ni, nitrides thereof and oxides thereof, and has a thickness of 200 to 30,000 Å.

(5) A ferritic stainless steel material having excellent rust resistance, characterized in that a ferritic stainless steel base material which contains, on a weight basis,

Al: 0.003 % or less; Si: 0.3 to 5 %;

Mn: 0.2 to 1 %; Cr: 8 to 25 % or less;

and at least one component selected from the following group:

Cu: 0.05 to 0.8 %; Ni: 0.05 to 0.8 %;

Nb: 0.05 to 2.0 %; and Mo: 0.05 to 3.0 %;

with the balance substantially being Fe, is first subjected to a dipping process in an oxidative or peroxidative acid solution or an electrolysis in an acid solution, and is then provided, on the surface thereof, with a single-layered or multi-layered coating layer by a vapor-phase plating method, said coating

layer being constituted of at least one component selected from the group consisting of Al, Ti, Si, Nb, Cr, Mo, Cu, Ni, nitrides thereof and oxides thereof, and having a thickness of 200 to 30,000 Å.

(6) A ferritic stainless steel material having excellent rust resistance, characterized in that a ferritic stainless steel base material which contains, on a weight basis,

Al: 0.1 to 4 %; Si: 0.3 to 5 %;

Mn: 0.2 to 1 %; Cr: 8 to 25 % or less;

and at least one component selected from the following group:

Cu: 0.05 to 0.8 %; Ni: 0.05 to 0.8 %;

Nb: 0.05 to 2.0 %; and Mo: 0.05 to 3.0 %;

with the balance substantially being Fe, is first subjected to a dipping process in an oxidative or peroxidative acid solution or an electrolysis in an acid solution, and is then provided, on the surface thereof, with a single-layered or multi-layered coating layer by a vapor-phase plating method, said coating layer being constituted of at least one component selected from the group consisting of Al, Ti, Si, Nb, Cr, Mo, Cu, Ni, nitrides thereof and oxides thereof, and having a thickness of 200 to 30,000 Å.

3. Detailed Description of the Invention

(Industrial Applicability)

The present invention relates to a ferritic stainless steel material (e.g. steel plate) having excellent rust resistance and to its production method.

(Prior Art and its Problems)

Recently, in the high growth economic environment, significant diversity has been found in life styles and value concepts. For example, in spite of its high cost, the use of stainless steels, which have an attractive and deep metallic luster, have excellent corrosion resistance and provide a unique high-grade appearance, have previously been adopted for construction materials and in other fields.

However, even stainless steels having the above-described excellent properties encounter problems with local reduction of luster, so-called "staining", and red rust under severe conditions, such as in coastal areas and areas where there is volcanic ash; thus, high grade image "rust free stainless steel" may be impaired in some cases.

Various proposals for solving the above-described problem have previously been disclosed including the following techniques and methods:

a) A technique wherein an alloy element, such as Cr and Mo, having an effect of improving corrosion resistance is added as a component to stainless steel in order to improve the properties of the stainless steel itself;

b) A method which is used for a bright-annealed material, wherein the management of frost point during the bright annealing is adjusted in order to improve the corrosion resistance of the oxide film which is provided on the outermost surface; and

c) A method which is also used for a bright-annealed material, wherein a stainless steel which has previously been bright-annealed, is subjected to a passivation treatment in an oxidative acid solution;

and these techniques have been even put to practice, but the resulting effects have not been satisfactory.

Hence, in view of the above-described situation, the conclusion was reached that "the reason why the conventional prevention of "staining" is unsatisfactory is that the corrosion environment is unexpectedly severe despite the fact that the environment of the formation of "stain" is restricted to a relatively small area, which is referred to as a "stain" forming part,

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and, in order to sufficiently inhibit or prevent the formation of the "stain", a corrosion-resistance layer which is superior to conventional oxide films must be provided on the outermost surface of the stainless steel material"; following this conclusion, attempts have been made to conduct several

techniques for preventing stains and red rust, such as the following techniques:

A) A method wherein a high corrosion resistant metal, such as Cr, is plated on the surface of a stainless steel.

B) A method wherein an organic resin coating film is applied to the surface of a stainless steel (i.e. coating method).

Unfortunately, the former "metal plating method" is not industrially desirable, given the fact that the regulations covering the waste water treatment are going to be more strict in future, whereas the latter "organic resin coating method" may lose the characteristic metal luster and texture of stainless steels, which limits the usage of the stainless steel.

(Means of Solving the Problems)

From the above-described viewpoints, in order to solve the problems with the formation of "stains" and "red rust" without damaging the unique deep metal luster of the stainless steel and also in order to stably produce a high rust resistant stainless steel material on an industrial scale, the present inventor conducted intensive research while considering his own knowledge of corrosion-resistant coating films, which the present inventor has developed over long years of experience. As a result, the present inventor has obtained the following new findings. Specifically,

(a) Unlike conventional plating methods, the use of a vapor-phase plating method, which has been recently significantly advanced, such as a CVD (chemical vapor deposition) method, an ion plating method and a sputtering method, allows a thin film which is constituted, for example, of various metals, nitrides and oxides, to be formed on the surface of a stainless steel. Further, when a coating film which is constituted of a specific material and has a specific thickness is formed on the surface of a stainless steel by the vapor-phase plating method, the rust resistance of the resulting stainless steel can be markedly improved without impairing the unique luster of the stainless steel, thereby providing an improved prevention effect on the formation of "stains" and "red rust".

(b) However, in this case, when a commercially available conventional stainless steel material is used as a base material without any additional processes, a non-metallic inclusion which is exposed to the surface of the stainless steel material causes surface defects regardless of the type of material used for plating or of the vapor-phase plating method used, whereby a stable improvement in rust resistance cannot be expected.

(c) Further, of the non-metallic inclusions, the most common oxide-based non-metallic inclusions, particularly alumina-based non-metallic inclusions, are the most responsible for causing defects on plated films.

(d) However, a stainless steel material having excellent rust resistance can be quite stably obtained when a ferritic stainless steel material which contains a component which is appropriate for diminishing alumina-based non-metallic inclusions in the stainless steel material is used as a base material, is then optionally subjected to "a dipping process in an oxidative or peroxidative acid solution" or "an electrolysis in an acid solution" and is subjected to the above-described vapor-phase plating method.

The present invention, which is based on the above-described findings, is characterized in that:

"Excellent rust resistance is provided by producing a stainless steel material which contains:

M: 0.003 % or less, or 0.1 to 4 % (compositions are expressed by "wt %", hereinafter)

Si: 0.3 to 5 %; Mn: 0.2 to 1 %;

Cr: 8 to 25 % or less;

and at least one component selected from the following group:

Cu: 0.05 to 0.8 %, Ni: 0.05 to 0.8 %;

Nb: 0.05 to 2.0 %; and Mo: 0.05 to 3.0 %;

with the balance substantially being Fe, is provided, on the surface thereof, with a single-layered or multi-layered vapor-phase plated layer (obtained by a CVD method, an ion plating method, a sputtering method etc) which is constituted of at

least one component selected from the group consisting of Al, Ti, Si, Nb, Cr, Mo, Cu, Ni, nitrides thereof and oxides thereof, and has a thickness of 200 to 30,000 Å".

Further, the present invention is also characterized in that:

"A ferritic stainless steel material having excellent rust resistance can be stably obtained by a ferritic stainless steel base material which contains,

Al: 0.003 % or less; or 0.1 to 4 %;

Si: 0.3 to 5 %; Mn: 0.2 to 1 %;

Cr: 8 to 25 % or less;

and at least one component selected from the following group:

Cu: 0.05 to 0.8 %; Ni: 0.05 to 0.8 %;

Nb: 0.05 to 2.0 %; and Mo: 0.05 to 3.0 %;

with the balance substantially being Fe,

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is first subjected to a dipping process in an oxidative or peroxidative acid solution or an electrolysis in an acid solution, and is then provided, on the surface thereof, with a single-layered or multi-layered coating layer by vapor phase plating, said coating layer being constituted of at least one component selected from the group consisting of Al, Ti, Si, Nb, Cr, Mo, Cu, Ni, nitrides thereof and oxides thereof, and having a thickness of 200 to 30,000 Å".